

STAT

[REDACTED]
552 MDRI PRODUCT IMPROVEMENT
UTILIZING

STAT

[REDACTED]
OPTISYN Encoders

STAT

Increase capability and flexibility of present 552
Stereo Viewer by modifying same to include automatic digital
comparator features.

[REDACTED]
Project Engineer

STAT

Declass Review by NIMA / DoD

STAT

GENERAL

STAT

STAT The 552 Point Marking System will be modified to have Automatic Comparator-Mensuration capability. A measurement system employing [] OPTISYN encoders with [] solid State counters, shielded cables of proper length, displays and readout-record provisions will be supplied by the customer for installation []

STAT

STAT

Automatic X-Y coordinate measurements of photo points are obtained through encoders attached to precision lead screws. [] supplied Panel Controls will permit zero reset, data printout/recording on demand. Any extra data entry switches will be supplied by customer for installation on the control panel.

STAT

SCREWS

Precision ground ball lead screws 2 1/2mm pitch; one (1) micron per inch maximum lead error, five (5) microns per foot accumulative lead error. Maximum lead error including thread drunkenness over 2 1/2mm is expected to be better than 1/2 micron.

ENCODERS

STAT Four (4) incremental photo optical type encoders, manufactured by [] will be employed. Each will provide 2,500 counts per revolution, or a one (1) micron bit size with an expected accuracy count of $\pm 1/4$ micron, (according to manufacturer).

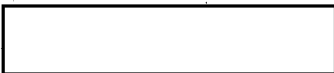
Declass Review by NIMA / DoD

NOTE: The size of these encoders, approximately 2 3/4 diameter by 2 1/4 inch length, will also require modification of the systems' X and Y carriage and base castings as explained in the Work Statement below. In addition, the standard encoder connector must be replaced by a potted pig tail arrangement to avoid lateral interferences.

STAT

READOUT, LOGIC AND DISPLAYS

To be supplied by customer, will contain six (6) digit counters, registers, and visual displays with provisions for recording measured data and extra identification data on printout equipment. Each axis will have a six (6) digit numerical display, the least significant count representing a one (1) micron bit. Customer will provide shielded cables of a length specified by

 connectors and closures to house these components.

STAT

NOTE: A count rate capacity of approximately 25kc is required. Also, zero reset switches should be provided for each axis on the individual counter display panels.

LIFE EXPECTANCY OF ENCODERS

The manufacturer's expected average mean time to failure of this optical type encoder is six (6) years and is dependent upon the life of the lamps and precision Ball Bearings. This greatly exceeds the maintenance free life expectancy of Brush type encoders.

CONTROL

[] will provide ON-OFF power switch, data readout and zero reset switch at the operator's control panel. Power 110/120 volts A.C. 60 cycles. Customer to supply cables from [] equipment to readout and counters.

STAT

STAT

SYSTEM PERFORMANCE

Digit bit size - one (1) micron.

Maximum speed 1/2 inch to 3/4 inch per second, approximately.

ACCURACY

[] design objective is to provide the 552 System with a repeatability of one (1) micron and an average measurement accuracy of approximately one (1) micron over short distances. Long distance measurement goal is to provide an accuracy better than $2 \frac{1}{2}$ microns plus .005% of distance travelled.


STAT


[] On the basis of an accuracy analysis included below, [] believes the following accuracies can be achieved.


ILLEGIB

STAT

Specified System Total Accuracy:

 $2 \frac{1}{2}$ microns or $\pm 1 \frac{1}{4}$ microns up to 1 millimeter.

 $3 \frac{1}{2}$ microns or $\pm 1 \frac{3}{4}$ microns up to 20 millimeters.

 System Accuracy: $2 \frac{1}{2}$ microns + .005% over distance travelled.

We are confident that the basic design of the Stereo viewer has sufficient rigidity to provide these, or greater, system accuracies.

STAT

However, because the magnitude of the problem requires advancing the state of the art in large format stereo viewers, there is a high risk in determining what the final accuracy will be. The exact results will not be known until the system is being tested.

The best possible engineering and practices are being applied. For example, [] has made the same type lead screw as is used on the viewer to an accuracy of 1/4m. Obtaining a guarantee to this is impossible.

STAT

ACCURACY ANALYSIS

STAT

LEAD SCREWS AND NUTS

2 1/2mm pitch accuracy specified as .000040 maximum lead error per inch, but not to exceed .0002 inch per foot of ball thread cumulative.

According to tests conducted by the manufacturer, [REDACTED] a total deviation .000040 inch per inch is practical and is normally surpassed in order for the manufacturer to qualify the overall tolerances. Actually, [REDACTED] has verified accuracies better than these specified above for similar [REDACTED] ball screws.

STAT

STAT
STAT

BALL BUSHINGS

These contain class 1 balls and are loaded to eliminate play. System effects due to eccentricity in the balls are expected to be lower than 5-10 millionths.

STRAIGHTNESS OF WAYS

The rod ways are obtained with an initial straightness of .0002 inch per foot. These will be further straightened by adjustment every six (6") inches across its length.

Straightness is expected to be better than .000030 inch per inch. Kinematic design reduces this figure by a factor of two (2). Elasticity of final machined members has been predicted as being less. However, the aggregate elasticity of final system will not be known until completion.

HYSTERESIS AND DEFLECTION DUE TO VARIOUS FORCES FROM FIBER OPTIC CABLES, OPTICAL TURRETS, SCREWS, CARRIAGES AND WAYS

STAT

Special efforts in Kinematic design have been made to provide low torque-flexible fiber optic cable coverings, rigidized meehanite castings, shortened lever arms and low hysteresis components as in house product improvements over previous designs. It is, therefore, estimated that approximately 1 1/2 microns will be contributed by these factors.

REPEATABILITY

Ball Screws

The repeatability of the ball screws in accordance with these tests conducted by should be in the order of 10-20 millionths. STAT

Ball Bushings

The effects of eccentricity and accuracy of the balls is 5-10 millionths. Hence, repeatability error due to the ball bushings is not expected to exceed 1/4 micron.

Hysteresis and Deflection Due to Various Forces on the Carriages

The repeatability error due to hysteresis and other effects is expected to be approximately one (1) micron.

552 SYSTEM TOTAL ACCURACY RELATIVE TO DISTANCE TRAVELLED

0 -1mm: 2 1/2 microns, or + 1 1/4 microns

20mm: 3 1/2 microns, or + 1 3/4 microns

552 SYSTEM REPEATABILITY

STAT

Within 1 3/4 microns.

NOTE: The above system accuracy and repeatability does not include the accuracy of the digital readout system. However, it does include any error due to connection between the output shaft and the digitizer. If the OPTISYN Encoder is used, then an additional + 1/4 counts error is added, as specified

STAT

a measure of the individual operator's repeatability.

PROPOSED METHOD OF CHECKING ACCURACY AND REPEATABILITY

STAT

ACCURACY CHECK

To check the system accuracy [] will employ a master linear standard, certified by the National Bureau of Standards, to be calibrated within one (1) micron. An average of five (5) readings taken from one direction only will be recorded for each point on this calibrated grid to determine linear measurement accuracies. Grid was calibrated at 68 degrees F. If the test is made at other temperatures suitable thermocouples will be installed.

STAT

REPEATABILITY

To check for repeatability, a reticle line, star image, or scale will be placed on the film platten. The operator will locate this point through the optics and note the coordinates. He will then move off the point and return to the same point for a total of five (5) readings, always approaching from the same direction. The maximum difference of the five readings will be a measure of repeatability at this point. This procedure will be repeated at approximately six to ten different areas over each format.

It may be noted that this method of measurement is also checking operator repeatability. The target will be selected where that is minimal. The repeatability of the operator can be checked by using a microscope with a filar eyepiece set to the same magnification of the system. A measurement can then be made on the same target by using the filar microscope, thus providing a measure of the individual operator's repeatability.

WORK STATEMENT

STAT

And

INVESTIGATION OF PROBLEMS TO BE ENCOUNTERED IN INSTALLING

STAT

- A. Investigate feasibility of providing one (1) micron bit by direct coupling.
- B. 2 1/2mm precision ball screws will be provided.
- C. Provide for Installation of Y Encoders: (See attached sketch)
 - 1. Redesign and revise layouts, parts drawing, patterns and castings, brackets and miscellaneous mounting components and hardware.
 - 2. Y carriage castings must be modified and relieved locally to accommodate casting tolerances in order to make clearance for movement back and forth over the 2 3/4 inch diameter encoder.
 - 3. X carriage castings must be modified locally to fit 2 3/4 inch casting diameter of encoder. Also, rear rib must be cut to clear this same diameter.
 - 4. Special servo bracket to mount encoder. Extreme care and tolerances for zero backlash coupling of encoder to screw is required.
- D. Provide for Installation of X Axis Encoders: (See attached sketch)

5. Checkout overall system operation.

STAT

6. Debug and adjust for optimum performance.

1. Redesign and revise layouts, parts drawing, patterns and castings, brackets and miscellaneous mounting components and hardware. STAT
2. Cut back base mounting pads.
3. Enlarge pad areas for mounting brackets.
4. Special servo type encoder mounting bracket with close tolerance and alignment care for mounting.
5. Special extended shaft coupling zero backlash type.

B. Installation - Checkout

1. Install four (4) encoders (2 X and 2 Y axis), customer supplied. Customer will furnish encoders wired for proper direction of count. [] will specify which direction. STAT
2. Channel and tie down cables form encoders. These customer supplied cables must be approximately 18 to 20 feet long, and properly shielded against [] interference with connectors to tie into [] counters. STAT
STAT
3. Provide power cable 110V 60 cycles.
4. Provide ON-OFF switch, readout switch and zero reset switch on [] control panel; with shielded wires and terminating connector and mating connector with 15 foot of shielded wire, for paralleling [] system controls. STAT
STAT

CUSTOMER PROVIDED EQUIPMENT

STAT

Customer will provide a complete measuring and readout system which will contain the following:

A. Four (4) encoders, 2,500 counts per revolution, each with 18 to 20 foot of [] shielded cables.

STAT

B. Four (4) Solid State counters, six (6) digit up-down, resettable to zero, with approximately 25kc count rate.

C. Four (4) visual display banks, of six (6) digits, each with 20 foot cable, remote mounting as desired.

D. Enclosures and cabinets.

E. Connectors and cables to [] equipment. Types and lengths will be specified []

STAT

STAT